

**THE EFFECT OF HIGH TIDES ON SUNGAI DAMANSARA USING  
INFOWORK RS**

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## ABSTRACT

Tides are the cyclic rising and falling of the earth ocean surface. Tides are caused by the gravitational pull of the moon and the sun on the earth and its water. The moon has a stronger effect than the sun because the moon is closer to earth. Damansara catchments is located at west of Kuala Lumpur. Rapid development within the catchments has been on going over the years. Damansara area is an industrial and commercial area. Sungai Damansara is a tributary of Sungai Klang. Sungai Damansara catchment has an area of approximately 148 km<sup>2</sup> which comprises the six major tributaries. There are Sungai Pelemas, Sungai Pelumut, Sungai Payong, Sungai Rumpit, Sungai Air Kuning and Sungai Kayu Ara. Many flood occurred in this catchment area but the worst flood occurred on 26<sup>th</sup> February 2006. Model calibration has been carried out at Taman Sri Muda water level station. Manning coefficient,  $n = 0.03$  is suitable value roughness coefficient. This model was developed by using high and low flow as an input with different Return Period. This study was conducted to investigate the limit of tide during high tide and low tide. The results from the hydrodynamic modeling had indicated that the tidal effect can be seen clearly up to Section 22. From this point up to Kampung Melayu Kebun Bunga, a very small tidal variation was observed. Finally the tidal diminish at somewhere at TTDI Jaya which can be concluded that this is the limit of tides.

## ABSTRAK

Air pasang merupakan keadaan di mana aras air laut mengalami keadaan naik dan turun. Air pasang disebabkan tarikan bulan dan bintang pada bumi dan air. Bulan mempunyai kekuatan yang lebih besar berbanding dengan matahari kerana bulan terletak lebih dekat dengan bumi. Kawasan Damansara terletak di arah barat dari Kuala Lumpur. Pembangunan yang berlaku di kawasan ini adalah cepat dari tahun ke tahun. Damansara adalah kawasan perindustrian dan perdagangan. Sungai Damansara merupakan cabang Sungai Klang. Kawasan Sungai Damansara mempunyai keluasan kira-kira  $148 \text{ m}^2$  dan Sungai Damansara mempunyai enam cabang sungai utama iaitu, Sungai Pelemas, Sungai Pelumut, Sungai Payong, Sungai Rumpit, Sungai Air Kuning dan Sungai Kayu Ara. Kejadian banjir sering berlaku di kawasan ini tetapi banjir yang terburuk sekali telah berlaku pada 26 Februari 2006. Model penentukur telah dilakukan di stesyen penyukat aras air Taman Sri Muda. Pekali Manning,  $n = 0.03$  adalah yang sesuai digunakan sebagai pekali kekasaran pada model ini. Model ini dibangunkan dengan mengambil kira aliran tinggi dengan pelbagai kala kembali dan aliran rendah. Tujuan kajian ini adalah untuk menyiasat had limit air pasang besar. Berdasarkan keputusan daripada model hidrodinamik yang dibangunkan, kesan pasang surut berlaku sehingga Seksyen 22. Daripada kawasan ini sehingga Kampung Melayu Kebun Bunga, berlaku kejadian pasang surut tetapi perubahannya adalah sangat kecil, Air pasang surut tidak berlaku di kawasan TTDI Jaya yang mana ianya adalah melepasi had limit kawasan pasang surut.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

River is a natural watercourse, flowing toward an ocean or another river. A river is part of the hydrological cycle. Water within the river is generally collected from precipitation through surface runoff and groundwater recharge. The water in river usually confined to a channel, made up of stream bed between banks. In larger rivers there is also a wider floodplain shaped by flood water over topping the channel. The floodplain may be very wide in relation to the size of the river channel. This distinction between river channel and floodplain can be blurred especially in urban areas where the floodplain of river channel can become greatly developed by housing and industry.

Malaysia has the most beautiful river in the world. There are about 200 river systems in Malaysia. 150 river systems in Peninsular Malaysia while 50 river systems in Sabah and Sarawak. Rivers played a major and important role for shipping and influencing the development of the nation. Major towns in Malaysia are almost located beside the river. Malaysian river provided a means of transport, helped to establish ports and towns, provided a livelihood for riverine people irrigated the land, generated hydropower and influenced the culture and traditions of the people. Rivers in Malaysia have a wide variety of flora and fauna for recreational opportunities.

Malaysia located in humid tropic generally endow with fairly abundant rainfall in the order of 3000 mm annually with 57 per cent of surface runoff. 60 per cent of rain falls between November and January annually. In the recent past, rapid economic growth brought the problems of water imbalance especially where development is concentrated in water stress regions.

Malaysia also influenced by the alternating north east monsoon from mid November to March and south west monsoon. North east monsoon bringing with it heavy rain and flood, mainly hitting the east coast of Peninsular Malaysia. 9 per cent of the total land area in Malaysia is prone to flooding. It will affect approximately 2.7 million people. The annual average flood damage has been estimated at around RM100 million at 1982 price level. With the rapid pace of industrialisation and urbanization, the occurrence of flash flood in urban areas and along highways have also been in the rise.

Tides definitions relate to the alternate rise and fall of the surface of oceans, seas, and the bays, rivers, etc. connected with them, caused by the attraction of the moon and sun (Macmillan, 1966). It may occur twice in each period of 24 hours and 50 minutes, which is the time of one rotation of the earth with respect to the moon. And high tides can be defined as the highest level of high water and time when the tide is at this level.

Damansara catchment was located west of Kuala Lumpur. Development within the catchments has been on going over the years. The development has been gradual with areas in the fringes of Kuala Lumpur such as Damansara, Taman Tun Ismail being developed about 30 to 40 years ago. Sg.Damansara catchment now estimated to have a population of 226,000 in the year 2000 (Jurutera Perunding Zaaba Sdn. Bhd., 2008). The area contains important industries and areas of commercial and economic significance to the state

InfoWorks RS includes full solution modeling of open channels, floodplains, embankments and hydraulic structures. Uses the "ISIS" simulation engine, which is renowned for its flexibility The advantages of using this software are incorporates rainfall-runoff, flow routing, steady-state and full hydrodynamic methods within a



single simulation environment, includes continuous and event based rainfall-runoff simulation, solves the St-Venant equations using the Preissman 4-point scheme which is stable across a wide range of flow conditions, unparalleled support for modeling structures including weirs, sluices, bridges, pumps and culverts and also accommodates simulation of super-critical flows in both the steady-state and unsteady flow solvers.

## 1.2 Problem statement

Flood disaster emergencies are generally very sudden, the recent Shah Alam flood on Sunday 26<sup>th</sup> February 2006, when more than 2,000 flood victims had to run for their safety suddenly after a rainstorm at 5.00 am in the pre-dawn morning as shown in Figure 1.1. The New Klang Valley Expressway and the Malaysian Commuter Train railway were also suddenly closed at that time due to the flood. This area has experienced 12 flood events since 1994. The big flood occurred on December 1995, 6 December 1999, 5 January 2000 and the worst was on 26<sup>th</sup> February 2006. The Majlis Bandaraya Shah Alam (MBSA) has estimated numbers of house flooded was 1842 units with total damage was RM 27 million where average damage / house are RM 15,000. And also MBSA has estimated numbers of car submerged are 2800 units with total damages is around RM 14 million where average damage per car is cost about RM 5000.

Paper cutting on 27<sup>th</sup> February 2006, Utusan Malaysia reported that the flood occurred at TTDI Jaya and Batu 3 always connected due to high tide at that time. The worst flood occurred on 26<sup>th</sup> February 2006. Figure 1.2 shows the digital paper cutting reported that the king of tide occurs during this event. However, based on the tidal cycle, the high tide occur when the moon is full or new, the gravitational pull of the moon and sun are combined. The moon is full on 3/4 of the month and moon is new on 1/4 of the month based on Islamic calendar.



Figure 1.1 : Flooded at area TTDI Jaya on 26<sup>th</sup> February 2006



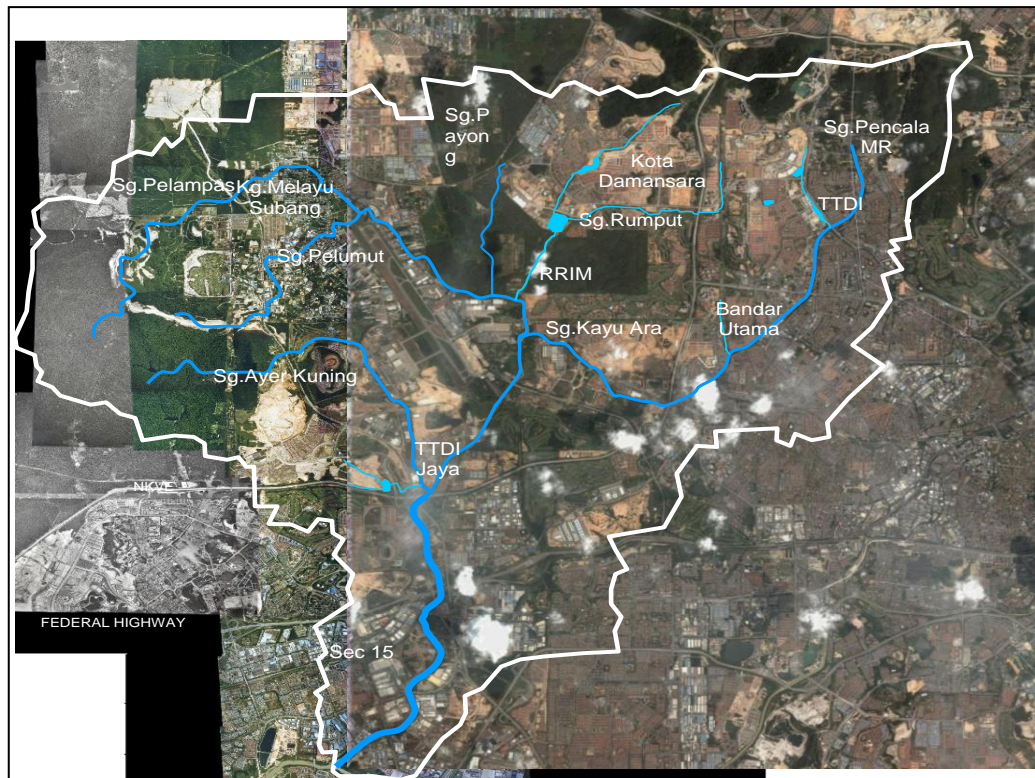
Figure 1.2 : Digital paper cutting on 27<sup>th</sup> February 2006

### **1.3 Area of study**

Sungai Damansara is a tributary of Sungai Klang. The river originates from the northern hilly forest of Sungai Buloh and flows towards the south and southeast. It is about 21 km long on its journey downstream. It joins with its major tributaries before eventually joining Sungai Klang. Sungai Damansara catchment has an area of approximately 148 km<sup>2</sup> which comprises the main Sungai Damansara and six major tributaries. These tributaries are Sungai Pelumut, Sungai Pelampas, Sungai Payong, Sungai Rumpit, Sungai Kayu Ara and Sungai Air Kuning.

Sungai Damansara and its tributaries have no major river regulating structures such as dams, or barrages. Most of the river stretches passing urban areas however have been channelized and straightened. Some stretches along Sungai Pelumut and Sungai Kayu Ara have been lined with concrete. Bunds have been constructed alongside Sungai Damansara from the confluence with Sungai Klang up to Subang Airport. Due to space constraints, bunds alongside Taman TTDI were replaced by flood walls.

This study is carried out around area of Sungai Damansara at Taman Tun Dr Ismail Jaya, (TTDI Jaya) at Section U2, Shah Alam. Figure 1.3 shows Sungai Damansara catchment area from the satellite image.



**Figure 1.3 : Sungai Damansara catchment area**

Sungai Damansara catchment has an area of approximately 148 km<sup>2</sup> with 16.2 km length. Sungai Damansara on average is about 20 m wide for the 10 km stretch from the confluence with Sungai Klang. At the same stretch, the depth of the river varies from 1 m to 2 m during normal flow. There are 33 bridges across Sungai Damansara and its tributaries. Figure 1.4 shows the bridges at various locations.





**Figure 1.4 :** The bridges at various location

## **1.4 Objectives**

The objectives of this study are :

1. To develop a hydrodynamic computational model covering from river mouth
2. To investigate the effect of high tides and the location of tidal limit on the Sungai Damansara

## **1.5 Scope of study**

1. Develop a hydrodynamic model from computational model from river mouth (Port Klang) to upstream of TTDI Jaya where limit of tide is expected.
2. It will include flow from Sungai Klang upstream of the confluence
3. Carry out calibration at location which have tidal influence
4. Carry out hydraulic and hydrology simulation for high and low flow
5. Compare the water level at specific location to determine tidal effect

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

Tides are the alternating rise and fall of the sea levels. Water levels in seas and the rivers connected to them rise and fall approximately twice a day. Tides are caused by the gravitational pull of the moon and the sun on the earth and its water. The moon has a stronger effect than the sun because the moon is closer to earth. The earth makes one complete rotation on its axis per day. Therefore, a site on earth will face the moon once a day. For any place on earth, high tide occurs when the site is nearest (faces) the moon. Water levels rise as the moon's gravity pulls on the earth's water. The second time this site experiences high tide is when the site is farthest from the moon (about twelve hours later). At this moment, the moon's gravity is weakest. The water withstands being pulled away by the moon. And also, the centrifugal force of spinning earth contributes to this high level of water. When the earth turns, the site no longer faces the moon nor faces directly away from the moon, sea and river levels lower as the moon pulls water away.

A rising tide called a flood tide. As ocean levels rise, seawater along the coast is pushed up into rivers that are connected to the ocean. The flood tide introduces seawater into freshwater environment of the river. Flood tides may travel as fast as

25 km per hour. They may temporarily reverse downstream current, so that the river flows upstream during the flood tides.

During certain days of the month, high tides are especially high, and low tides are especially low. These are called spring tides. They occur about twice a month. The moon makes one revolution around the earth each month (once every 29.5 days). Spring tides occur when the moon is lined up with the earth and sun. These happen two ways, when the moon is in between the earth and the sun and when the moon and sun are on opposite sides of the earth. The gravity of the sun and moon line up and cause these especially high tides.

## **2.2 Types of tides**

There are three common types tides (Figure 2.1) :

1. Semi diurnal – two high and two low tides per day about equal range
2. Diurnal - one high and one low tide per day (24 hours)
3. Mixed – two high and two low tides per day but different ranges

### **2.2.1 Semi diurnal tides**

High – low water sequence repeated twice a day. These tides usually reach about the same level at high and low tides each day

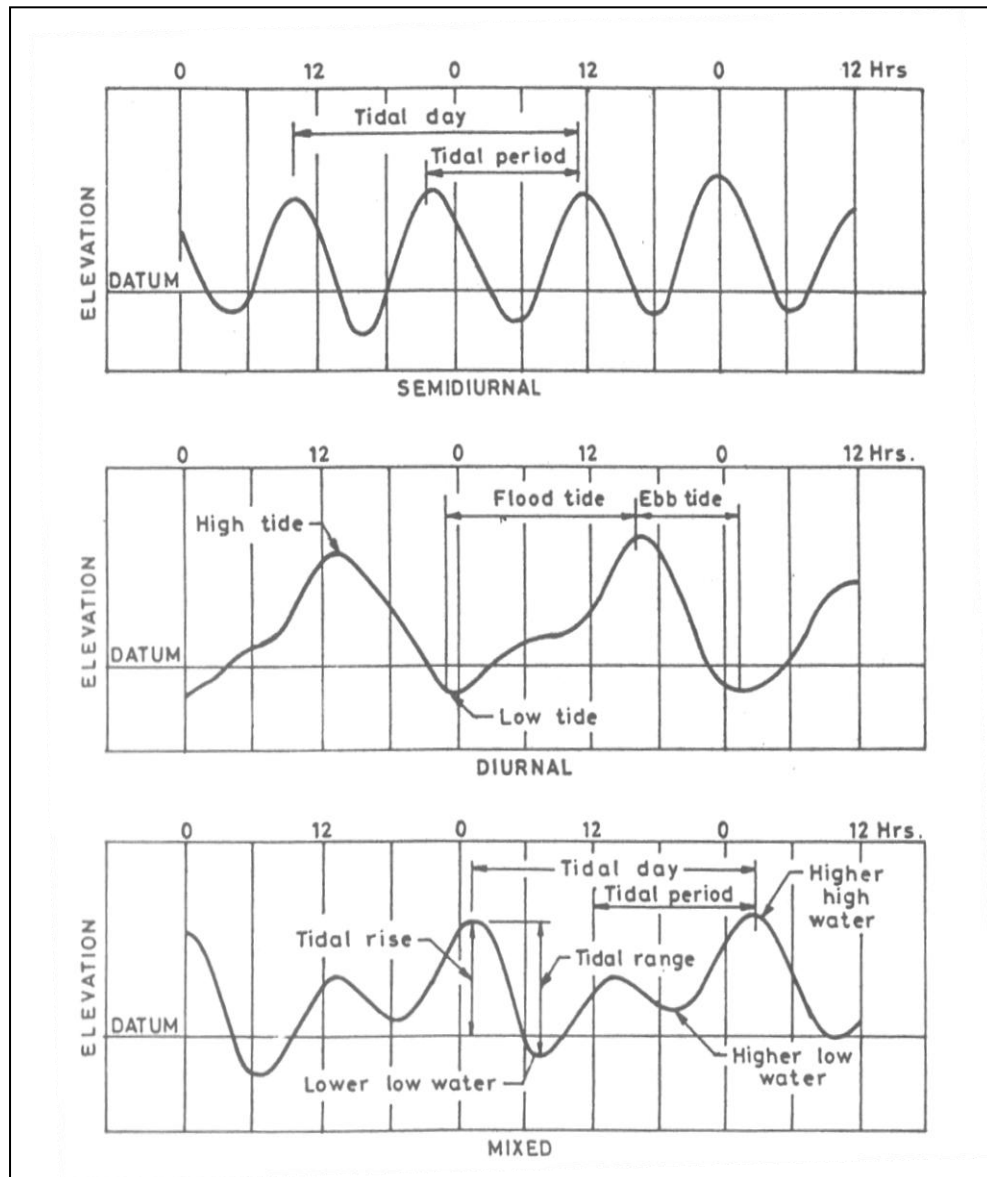
### **2.2.2 Diurnal tides**

At coastal area, there is a regular pattern of one high and one low tides each day.



### 2.2.3 Mixed tides

Tides has two high and low tides a day but the tides reach different high and low level during a daily rhythm.



**Figure 2.1:** Illustration the common types of tides.

## **2.3 Spring and neap tides**

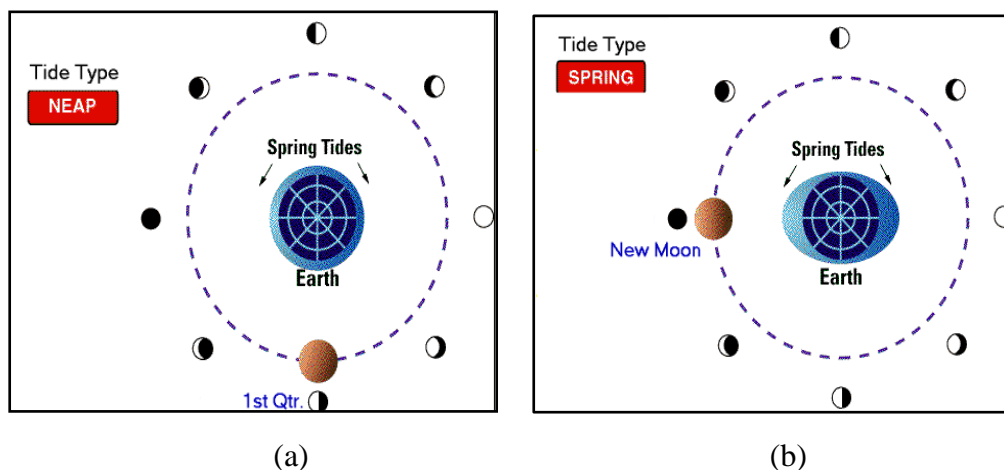
During the 29  $\frac{1}{2}$  days it takes the moon to orbit the earth, the sun and the moon move in and out of phase with each other. Figure 2.2 show the orientation of the sun, moon and earth on the quarter points of the moon's revolution about the earth.

### **2.3.1 Spring tides**

When the moon is full or new, the gravitational pull of the moon and sun are combined. At these times, the high tides are very high and low tides are very low. These are spring high tides. Spring tides are especially strong tides. They occur when the earth, the sun and the moon are in a line. Spring tides occur during the full moon and the new moon.

### **2.3.2 Neap tides**

During the moon's quarter phases the sun and moon work at right angles, causing the bulges to cancel each other. The result is smaller difference between high and low tides and is known as a neap tides. Neap tides are especially weak tides. They occur when the gravitational forces of the moon and the sun are perpendicular to one another. Neap tides occur during quarter moons.



**Figure 2.2 :** Illustrations of (a) Neap tides (b) Spring Tides

## 2.4 Major tidal components

Doodson (1941) provided a list of eight of the major components with their common symbols, period and relative strength, which M2, S2 N2, K2, K1, O1 and P1. As general tidal constituents represent in Table 2.1, 2.2, 2.3 and 2.4.

**Table 2.1 :** Semi-diurnal Constituents

| Name | Description  | Hourly Speed (°) | InfoWorks UNIT CODE |
|------|--|------------------|---------------------|
| M2   | Principal lunar constituent  | 28.98            | M2                  |
| S2   | Principal solar constituent  | 30.00            | S2                  |
| N2   | Allow for the changes in the Moon's distance due to its elliptic orbit round the Earth           | 28.44            | N2                  |
| L2   |  | 29.53            | L2                  |
| K2   | Allow for the effect of the declination of the Sun and Moon and of changes in the Sun's distance | 30.08            | K2                  |
| T2   |  | 29.96            | T2                  |

**Table 2.2 : Diurnal Constituents**

| <b>Name</b> | <b>Description</b>  | <b>Hourly Speed (°)</b> | <b>InfoWorks UNIT CODE</b> |
|-------------|---|-------------------------|----------------------------|
| K1          | Allow for the effect of the Moon's declination                      | 15.04                   | K1                         |
| O1          |   | 13.94                   | O1                         |
| K1          | Allow for the effect of the Sun's declination                       |                         |                            |
| P1          |   | 14.96                   | P1                         |
| Q1          | Allow for the effect of changes in the Moon's distance on K1 and O1 | 13.40                   | Q1                         |
| M1          |   | 14.49                   | M1                         |
| J1          |   | 15.59                   | J1                         |

**Table 2.3 : Quarter-diurnal Constituents**

| <b>Name</b> | <b>Description</b>   | <b>Hourly Speed (°)</b> | <b>InfoWorks UNIT CODE</b> |
|-------------|--|-------------------------|----------------------------|
| M4          | First shallow water harmonic of M2 with a speed twice that of M2   | 57.98                   | M4                         |
| MS4         | Shallow water constituent produced by the interaction of M2 and S2, with speed equal to sum of speeds of M2 and S2 | 58.98                   | MS4                        |

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